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BERRY'S CREEK: A GLANCE BACKWARD AND A LOOK FORWARD

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ABSTRACT

Berry's Creek is a tidal tributary in Bergen County, New Jersey between the Hackensack and Passaic Rivers, which extends almost seven miles from its discharge into the Hackensack River upstream towards its origins just south of Teterboro Airport (Figure 1). The approximately 12 square miles of the Berry's Creek watershed (about 8% of the total Hackensack River watershed) includes numerous marshes, channels, wetlands, and drainage ditches that serve as habitat to hundreds of plant and animal species (USEPA et al., 2005). Widely recognized as one of the keys to the sustained ecological viability of the Meadowlands, Berry's Creek and its associated canals also hold the distinction of being one of the most contaminated waterways in northeastern U.S (USEPA, 2008a).



Figure 1. Aerial view of the Berry's Creek watershed in relation to the Passaic and Hackensack Rivers as shown on NJDEP's GIS.

In 1929 the F.W. Berk Company (later known as the Wood-Ridge Chemical Company) opened its doors as a mercury reclamation and recovery center. This facility would process spent

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or off-spec fungicides, pesticides, batteries, thermometers, dental amalgams, and other mercury containing wastes and remove or recover the mercury for re-sale or reformulation into new products (USEPA, 2006). By 1974, when operations at its 40-acre site ceased, the plant had changed owners and names several times and some estimates have indicated that up to 270 tons of mercury could have been discharged into portions of Berry's Creek, but the actual amount of mercury released from point sources on the Creek is unknown (i.e., could be more or less). Based on one study, at its peak operation, between two to four pounds of mercury were being released into Berry's Creek every day (NJDEP, 1992). Additional investigations are ongoing that will provide further data on the validity of these estimates.

In 2005, USEPA completed its Framework Document for Berry's Creek (USEPA et al., 2005), which attempts to establish the guidelines for the characterization and investigation of the mercury and other heavy metal contamination present in Berry's Creek sediments. Critical to the success and effectiveness of these upcoming characterization activities is an understanding of not only how the contaminants were released but also the most probable (and implementable) remedial alternatives available for the waterway. Our presentation provides both a historical perspective on the discharges into Berry's Creek and establishes an ecological framework in which to consider and carryout future cleanup actions.

Keywords: Berry's Creek, Superfund, mercury, sediment remediation

1.0 INTRODUCTION

In 1929, the F.W. Berk Co. began operations in a newly constructed warehouse in the boroughs of Wood-Ridge and Carlstadt, NJ. The business grew quickly, capitalizing on its location close to the industrial centers of both New York City and New Jersey. F.W. Berk Co. provided a needed service: it recovered and re-processed mercury from batteries, medical instruments, thermometers, electrical switches and numerous types of industrial equipment (Exponent Engineering, 2004). This heavily industrialized area of southern Bergen County (Figure 2) was a perfect setting for a dirty business. And for the next 45 years, F.W. Berk Co. and its successors would discharge their mercury laden wastewater into Berry's Creek, a tributary of the Hackensack River. F.W. Berk Co. also would discard unwanted or unrecoverable mercury residues onto the land surrounding its warehouse (NJDEP, 1992). Eventually, many tons of mercury would flow into Berry's Creek and over 160 tons of mercury would be dumped onto the soil at the site (USEPA, 2008a).

As economic conditions changed, the property would be split in two and F.W. Berk Co. would be bought and sold, passing through several different owners and finally be closed by its last corporate proprietor Ventron in 1974 (Exponent Engineering, 2004). By then the damage was done and the Ventron/Velsicol site and the entire length of Berry's Creek were added to the National Priorities List (i.e., designated as a Superfund site) in 1984 (USEPA, 2006). The majority of cleanup activities at Ventron's real property parcel was accomplished fairly quickly, although some remedial actions are still ongoing. Addressing the environmental and ecological issues associated with Berry's Creek has been slower and much more problematic.



Figure 2. Aerial view of the industrialized Berry's Creek watershed as shown on NJDEP's iMapNJ.

2.0 HISTORY AND SETTING OF BERRY'S CREEK

Located within the Hackensack Meadowlands, Berry's Creek is a 6.5 mile long (10.5 km), stream that divides this mostly industrialized area of Bergen County roughly along a north-south line that is sub parallel to the New Jersey Turnpike (USEPA et al., 2005). According to the Rutgers University Engineering Soil Survey of New Jersey for Bergen County (Report No. 4), Berry's Creek lies within the Piedmont physiographic province. The survey shows that the area is underlain with an organic layer, locally called meadow-mat, followed by stratified silty-clays and clays. Bedrock in the area has been identified as being from the Passaic Formation at depths ranging from 250 to 300 feet bgs (Lueder et al., 1952). The natural drainage pattern of the watershed has been greatly affected by the over development (urbanization) of the marsh land. The majority of water is now diverted through Berry's Creek Canal to the Hackensack River, with the widest part of the creek measured at 200 feet (USEPA et al., 2005).

Berry's Creek two branches (locally called East Branch and West Branch) drain a 12 square mile watershed that contains approximately 20 NJDEP identified known contaminated sites and three Federal Superfund sites (USEPA, 2008b and NJDEP, 2008). USEPA's Berry's Creek Study Area is comprised of Berry's Creek, the Berry's Creek Canal, all tributaries to Berry's Creek from its headwaters to the Hackensack River, and its associated wetlands. Its also includes upland properties in the watershed and some tidal portions of the Hackensack River (USEPA et al., 2005).

3.0 CURRENT REMEDIAL PHASE

Currently the Berry's Creek Study Area is undergoing a Remedial Investigation/Feasibility Study (RI/FS). The EPA recently signed a settlement agreement with 98 potentially responsible parties (PRPs) to conduct a comprehensive investigation of the waterway's sediment, water, and biota. The study, which will be detailed in a work plan scheduled for release in September 2008, will include sample collection and assessment as well as an examination of potential cleanup alternatives. Data collected during scoping activities initiated in 2007 will be used in the

preparation of the RI/FS, as well as the collection of new data slated to begin in 2009. Following the data collection and feasibility study, a Proposed Plan will be prepared and published for public comment. Potential remediation alternatives of the Berry's Creek watershed will be derived from previously successful remediations at other watersheds. The most common cleanup activities include dredging and capping of contaminated sediment. The RI/FS will evaluate the potential effectiveness of these techniques. Final decisions will be detailed in a Record of Decision (USEPA, 2008c).

4.0 COMPARISON TO OTHER CONTAMINATED WATERSHEDS

The situation at Berry's Creek certainly is not unique to either New Jersey or the rest of the Country. A 1992 nationwide study by USEPA identified almost 100 watersheds whose sediments had been significantly impacted by industrial discharges and contained an estimated 1.2 billion cubic yards of contaminated silt, sand, and clay residues that require remediation (Deason, 2001). In order to place Berry's Creek within an environmental context, we have compared it to four watersheds.

The Tittabawassee River (TR), located near the eastern coast of Michigan, is a tributary of the Saginaw River (SR) which flows into Saginaw Bay in Lake Huron. The TR drains approximately 2600 square miles of land in the SR watershed. Contamination has been identified as being pervasive through 24 miles of TR and floodplain as well as up to 25 miles of the SR due to the operations of Dow Chemical Corporation. Dow, a chemical manufacturing plant, began operations in 1897 at their 1,900 acre facility in Midland, Michigan, which abuts the eastern side of the TR. Due to brine electrolysis of chlorine manufacturing, byproducts including dioxins, chlorobenzene, heavy metals and furans were released into the river (USEPA, 2008d).

USEPA ordered Dow to begin cleanup of three hot-spots on the TR and one hot-spot on the SR at Wickes Park, which began in 2007. Approximately 54,000 cubic yards (cu yds) of soil, bottom deposit, sediment, submerged sediment, riverbank, and floodplain have been dredged and excavated from the TR and SR. Water was treated in Dow's waste water treatment plant and discharged to the river. The river banks were cutback and stabilized and the floodplains were re-vegetated. Dioxin contaminated material was capped in a landfill on the Dow site (USEPA, 2008d).

The Hudson River drains approximately 13,400 square miles of watershed into the Atlantic Ocean. Its main channel is over 315 miles long and the watershed is a National Heritage Area. The river is divided into two sections known as the upper Hudson and the lower Hudson. The upper Hudson is between Hudson Falls and the Federal Dam (Lock) at Troy, NY, which was constructed in 1916 to improve access between the Hudson and the Erie Canal. The stretch is approximately 40 miles long, is separated into sections or pools by eight smaller dams and locks, and provides navigational control for the Champlain Canal. Currently, there is a commercial fishing ban; however sport fishing is allowed, with consumption restrictions. The lower Hudson is a tidal estuary that stretches approximately 153 miles between the Battery in Manhattan and the Federal Dam (USEPA, 2008e).

General Electric (GE) operated facilities in Ft. Edward and Hudson Falls, NY. In 1940 GE started using polychlorinated biphenyls (PCBs) for the fabrication, repair, and refurbishing of capacitors. GE legally discharged PCB-laden water into Hudson River from 1947 to 1977. Approximately one million pounds of PCBs was discharged, with an estimated 500,000 to 660,000 pounds remaining in the river. The sediment originally accumulated downstream from

the plants behind a rock-filled, timber crib dam at Ft. Edward. The dam was removed between July and October 1973 and upon dam removal and several subsequent flood events PCBs spread along entire length of the lower Hudson River (USEPA, 2002).

Remedial actions began in the mid-1970s, with the removal of over 770,000 tons of PCB sediment from the navigational channel of Champlain Canal. Contaminated material was either buried or capped along the river banks and breaks and fractures in the bedrock were grouted. A ground water collection system was installed to capture PCB contaminated ground water that was leaking into the river. By mid 2001, more than 3,000 gallons of PCB liquids had been recovered and shipped offsite for disposal. Over 230 ground-water recovery and monitoring wells were installed to create a hydraulic barrier between the Hudson Falls site and the river. Future remedial actions include the removal of grossly contaminated sediment. Contaminated dredge spoils are to be de-watered and stabilized at a special processing facility and shipped to a designated disposal site (USEPA, 2008e).

The Savannah River forms most of the border between Georgia and South Carolina. It is approximately 350 miles in length, where it begins in Lake Hartwell and ends in the Atlantic Ocean near Savannah, Georgia. The Savannah River watershed is approximately 10,500 square miles and drains areas in North Carolina, South Carolina, and Georgia. The Savannah River flows through four physiographic provinces which include the Blue Ridge Mountains, the Piedmont, the Upper Coastal Plain, and the Lower Coastal Plain. The river is bounded by agricultural land and industrial properties, including a current nuclear power plant and a former nuclear weapons facility. The river has been an integral part of life in the bordering areas, as it supplies water to cities including Augusta and Savannah. It also provides water to two nuclear reactors and an electric-generating plant (Savannah Riverkeeper, 2008).

The U.S. Department of Energy (DOE) and the Atomic Energy Commission (AEC) operated a 310 square miles (192,000 sq acres) facility known as the Savannah River Site (SRS) adjacent to the Savannah River in Aiken and Barnwell Counties, South Carolina. It is a secure government facility 25 miles south-east of Augusta, Georgia, that was constructed during the 1950s to produce basic material's used in fabrication of nuclear weapons, primarily tritium and plutonium-239. The facility maintained five reactors, two chemical separation plants, heavy water extraction plant, a nuclear fuel and target fabrication facility, and a waste management facility. Production was discontinued in 1988 and since then it has been identified that past disposal practices have lead to soil and groundwater contamination. With 515 inactive waste units identified, the site was added to the NPL in 1989 (USEPA, 2008f). These waste sites directly impacted the Savannah River and associated wetlands. However, after the discharges were controlled, natural processes isolated the contamination and clay mats were installed to cover radiological hot spots.

The Passaic River, which forms the boundaries between several counties in northeastern New Jersey, is a tributary of Newark Bay. The river is approximately 80 miles long and drains an 835 square mile watershed (Passaic River Coalition, 2008). The lower Passaic River is approximately 17 miles long, is tidally influenced, and runs from the Dundee Dam in Garfield to Newark Bay. This portion of the river has been industrialized for over a century and investigations have shown the river to have severely degraded water quality and sediment contamination (USEPA, 2007). Studies conducted by USEPA and other regulatory agencies have identified contaminants including dioxin, PCBs, pesticides, and heavy metals. In the mid-1940s pesticide manufacturing began in Newark, which included the production of DDT, phenoxy herbicides, and chemicals used in Agent Orange. From 1951 to 1969 the Diamond Alkali Company, predecessor to the Diamond Shamrock Chemical Company, operated a pesticides manufacturing company adjacent to the Passaic River. This site was added to the NPL

in 1984 and is divided into three operable units which include the former pesticides plant and surrounding areas, the lower Passaic River, and the Newark Bay Study Area (USEPA, 2008g). Occidental Chemical Corporation (f/k/a Diamond Shamrock Chemical Company) is responsible for remedial actions at the property and the Newark Bay Study Area. Cleanup of the Lower Passaic River is being assessed by a partnership of various federal and state agencies and is being funded by 73 PRPs.

In December 1995, pilot studies were conducted to evaluate environmental dredging and sediment decontamination technologies. The sediment was treated with sediment washing technology, which would be used for upland remediation or landscaping, and by Cement-lock thermal destruction technology, which would be blended with Portland cement to make industrial grade blended cement (USEPA, 2005). Currently six alternatives have been considered for remediation of the lower eight miles of the river including: (1) dredging of fine grained sediment; (2) capping the sediments with clean materials; (3) reconstructing a Federally-recognized navigation channel with a combination of capping and backfilling; (4) construction of a new navigation channel for current use and capping; (5) constructing a new navigational channel for future uses once the river is restored and capping; or (6) constructing new navigation channel for future use, dredging fine-grained material from one mile stretch with highest concentrations and one mile stretch where most erosion takes place, then capping (USEPA, 2007).

These other river basins are compared to Berry's Creek in the following table:

Comparison of Selected Contaminated Surface Water Bodies							
No.	Name	Location	Watershed Size (mi ²)	Hydrologic Connection	Contaminant	Use Restrictions	Planned/Actual Remediation
1	TR and SR	MI	2,600 sq miles	Saginaw Bay – Lake Huron	Dioxin	Fish and Game consumption advisory	Dredging and encapsulation of material
2	Hudson River	NY	13,400 sq miles	New York Harbor	PCBs	Fish consumption advisory	Dredging and encapsulation of material
3	Savannah River	SC	10,500 sq miles	Atlantic Ocean	Radio-nuclides	Fish consumption advisory	Encapsulation of material
4	Passaic River	NJ	935 sq miles	Hackensack River – Newark Bay	Dioxin, Mercury, PCBs	Fish and Shellfish consumption advisory	Dredging and/or encapsulation of material
5	Berry's Creek	NJ	12 sq miles	Hackensack River	Mercury	Fish consumption advisory	Yet To Be Determined

5.0 PATH FORWARD

The ecological, contaminant, and risk/exposure conditions compelling sediment cleanup at the Savannah River Site in western South Carolina, along the Hudson River in New York, within

the banks and channels of the Tittabawassee and Saginaw Rivers in Michigan, and (planned) for New Jersey's Passaic River, are very different (Table 1).

Yet despite the geographic, hydrologic, and demographic diversities of these watercourses, there are a series of fundamental factors that are driving the remedial program at each of these sites, except at Berry's Creek. These include:

- The contaminants are mobile in surface water and have been detected in benthonic and other higher levels species in the food chain. In places, contaminant impacts have curtailed either recreational or commercial fishing and include consumptive advisories.
- Each watercourse is a major surface water body in itself, or enters other surface water bodies within its drainage basin. Usually, these water bodies serve as important sources of drinking water, or scenic or recreational resources.
- The potential for human or other high level species exposure is high. In many cases, farms and residential areas are immediately adjacent to the stream or along its major tributaries and local land users can come into direct contact with the contamination.

But these conditions are not within the Berry's Creek watershed, or are present at much reduced or restricted intensities.

Mercury within Berry's Creek sediment is relatively stable and is not often detected in surface water samples of the Creek. While sediment concentrations are high, those elevated values presumably now are present under a layer of stream sediment (feet to inches below the channel bottom) and are isolated, to a least a certain extent, from the ecosystem and direct contact with people. Throughout its history Berry's Creek was never an important fishery and served primarily as a "working river" used in transportation of goods and as a quick and easy way to dispose of unwanted waste products (NJSEA, 2005).

Today, while some recreational fishing is done, the heavily industrial character of most of the Creek, except for a short stretch near its southern terminus with Hackensack River is not conducive to waterborne sports, apart from perhaps the occasional canoeist or kayaker. Those industrial land uses adjacent to the Creek are unlikely to change in the mid to long term. The redevelopment of Giant's Stadium, expansion of Teterboro Airport, and construction of the Xanadu Mall all re-enforce the urban/commercial nature that Berry's Creek is and will continued to be surrounded by.

The remediation of Berry's Creek marks the beginning of a series of cleanup activities related to the major surface watersheds across New Jersey. NJDEP, with support from USEPA, currently is in the planning stage for the Passaic River and Newark Bay cleanup to be followed shortly by a similar effort for the Raritan River and Raritan Bay. The PCB dredging project within the Hudson River, although largely performed in New York but whose lower reach forms a portion of the approximately 20 mile border between New York and New Jersey, also serves to highlight the new emphasis placed on watershed ecological restoration by both New Jersey and Federal regulatory agencies. However, is the enormous cost and technical risks (i.e., potential contaminant re-mobilization) associated with the dredging projects commensurate with the ecological and public health threat posed by Berry's Creek and other, similar watershed contamination? The answer is far from unequivocal.

As seen in the Hudson River case, PCB levels in striped bass and other aquatic species have been decreasing steadily since the completion of remedial actions focused on the control and removal of upland sources (USDOJ et al., 2001). The EPA's order to remove, process, and dispose of (on land) large amounts of Hudson River sediments was and remains scientifically controversial and may not have been made solely on the basis of environmental or ecological risk mitigation factors.

Similarly, at the Savannah River Site, once discharges to the wetlands were controlled, local ecosystem processes were able to effectively isolate the contaminant mass fairly quickly. These naturally driven *in situ* mechanisms were helped dramatically through the addition of special clay mats that were applied over radiological hot spots. From a remedial selection standpoint, SRS had the advantage of being a large, government controlled tract of land where radiological impacts largely were contained within the boundaries of the facility.

Within the Tittabawassee River, Michigan Department of Environmental Quality has taken an approach that involves stabilization of stream banks and adjoining floodplains to reduce the potential for remobilization of dioxin impacted sediments. Dredging of Tittabawassee River sediments is planned for only local hot spots that may represent acute toxicity threats to indigenous aquatic and benthonic species (USEPA, 2008d). While private party class action lawsuits continue, these are economic recovery actions for perceived diminution of property values and seem unlikely to influence short-term remedial actions for the Tittabawassee River or its adjacent, dioxin impacted floodplain areas.

Berry's Creek is far from an ecological dead zone. Instead it is an important part of the surface water drainage system for the Meadowlands as well as a vital and functioning ecosystem. Planned remedial actions must be considered however, in light of the land use reality that surrounds Berry's Creek. This area of New Jersey is one of the most densely populated in the State and development pressure on the Meadowlands and its supporting tributaries will only continue to increase as New Jersey "smart growth" initiatives strive to re-invigorate Brownfield redevelopment. Therefore, the remedial goal for Berry's Creek cannot be one that seeks to return its 12 square mile drainage area to pristine and unspoiled conditions. Rather than seek to dredge every mercury ion from its bottom sediments for processing and on-shore disposal, presumably at a nearby disposal site, a more balanced way to address the ecological and public health risks that Berry's Creek sediments pose would be to develop a series of cleanup objectives that are consistent with likely exposure scenarios.

For those areas of the Creek where public access is likely to be encouraged and controlled, like DeKorte State Park near the Creek's southern terminus, and the area with some of the lowest mercury levels, conduct remedial actions consistent with Clean Water Act goals – make these waters "fishable and swimmable". If this involves dredging to remove mercury or other contaminant hot spots likely to be scoured during high flow events, then this should be done in the least ecologically disruptive manner possible. Of course, ongoing leachate discharges from the half-dozen or so former solid waste landfills that dot this part of the Meadowlands also will need to be addressed before fishable/swimmable water quality can be achieved.

In the more industrial parts of Berry's Creek, that two mile stretch north of Route 3 and south of Teterboro Airport, the development of less ambitious cleanup goals are called for. A remedial approach focused on reducing the potential for adverse public health effects from exposure to bottom sediments as well as preventing existing sediment contamination from serving as a source for downstream pollution are ones that should be considered. Berry's Creek receives parking lot, roof drainage, non-contact cooling water, and storm water runoff from hundreds of acres of industrial and municipal properties. It also is likely that there are numerous unpermitted

(illegal) discharges of sanitary and industrial wastewater from many of these same sources. It is unlikely and unrealistic to think that the Creek will ever be anything more than an imperfectly functioning, although basically ecologically sound, waterway that will always be limited by the impacts of the highly developed and urbanized area that surrounds it.

For this part of the Creek alternatives to dredging, including *in situ* stabilization of the larger areas of contamination, need to be considered. Isolating the mercury from what functioning ecosystem is present in this area is one very practical way to achieve those goals, without destroying those fragile ecosystems that have managed to develop and sustain themselves in this challenging environmental setting.

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